DESIGN GUIDELINES

AASHTO INTERIM STRUCTURAL PAVEMENT

DESIGN PROCEDURE

ADOPTED FOR ALL SEASON COUNTY ROADS

and

APPROVED BY THE COUNTY ROAD ASSOCIATION OF MICHIGAN

ENGINEERING COMMITTEE

ON

JANUARY 18, 1988

AS REVISED JANUARY 1989

PREFACE

This January 1989 edition of the 'Design Guidelines Adopted for All Season County Roads contains minor revisions of the guidelines approved in 1988

Primarily, it corrects minor errors in the original edition, some further editing, and updating of the artwork.

If you have any questions, or suggestions for improving these guidelines, please contact

Local Services Division
Michigan Department of Transportation
P O Drawer 30050
Lansing MI 48909

INTRODUCTION

The two more critical elements of the design procedure are

1. Traffic, particularly commercial.
2. Subgrade soils

The normal design period for AASHTO pavement design is twenty (20) years However it was decided that, in some cases a minimum design period of ten (10) years could be used for resurfacing or rehabilitation projects

A serviceability index of 2.0 is used for most county roads and city streets and the index is the same for both flexible and rigid pavements. If the ADT (Average Daily Traffic) exceeds 5000 a serviceability index of 2.5 is used.

Traffic and the conversion into equivalent 18 Kip Axle loads are applied in the same way for flexible and rigid pavement design.

Life cycle costing has not been applied in this analysis.

Drainage is one of the most important factors in road performance. It is not only important during design and construction, but also must be maintained. Water in the subgrade or base must be controlled by under drainage. Pavements and shoulders should be built to proper crown and slope Run-off water must be controlled by ditches or under drainage Proper maintenance of shoulders to prevent berms or secondary ditches cannot be over emphasized. Ditches should be maintained by cleaning out as required and brush should be removed. Underdrains should be checked periodically for cleanout or broken sections

Treatment of swamps was discussed and it was decided that existing roads may be floated over swamps depending on economics and environmental effects. Before a decision is made to float over a swamp the depth and extent of the swamp as well as the depth of and type of existing fill should be known With this information and an evaluation of environmental effects a decision can be made whether to excavate and backfill the swamp or whether to float the existing fill. If not treated, expect maintenance costs and try to inform the public of future maintenance.

If you require more assistance, or if resurfacing on a concrete pavement is proposed contact the Local Services Division or the district soils and materials engineers for assistance.

ALL SEASON LOADING OUTLINE FLEXIBLE PAVEMENT

I. SERVICEABILITY INDEX p_t

A. As developed in the AASHTO road test, reflects pavement condition at end of design period, usually 20 years.

B For most reconstruction widenings resurfacings secondary trunklines turnbacks federal aid secondary county primary and other lower volume routes with ADT's less than 5000 use p_t = 2.0 chart.

When the ADT exceeds 5000 use p_t = 2.5 Chart

C. Both serviceability index charts are attached. Attachment C (pp 9 and 10)

II. SOILS Soil Support Value S

A. Are plans available showing existing typical cross section and subgrade textures?

B If not borings should be made.

1 Boring locations and depth

a. Approximately 300' to 1000' depending on uniformity of existing cross section thicknesses and subgrade. Closer spaced borings if necessary

b Vary pattern from side to side

c. 3 to 5 depth. 5 recommended

d. Concentrate on distressed areas to determine whether base correction is needed. May require closer boring pattern.

e. Determine water table, if present.

f. If widening existing pavement obtain borings in shoulder and determine whether subbase is full width.

g. If peat or muck is present, borings or soundings should outline the extent (depth including depth of existing fill width within proposed cross section and length)

C. In the application of the soil support value the following is assumed

1 Subgrades have been corrected where required to prevent frost heaves

2. Proper grade heights are designed.

3 Unsuitable material such as topsoil peat, etc. has been removed

4 Suitable compaction has been obtained

D Soil Support Values S A Measure of Subgrade Support

1. Value ranges from 1 to 10 Use information from old plans borings soils maps soils surveys, and engineering judgment to determine soil texture of subgrade. Reduce value for combination of wet soils and grade below recommended heights.

2. See Attachment A (Soil Support Chart, page 7) to determine soil support value, which is based on texture of subgrade.

III. TRAFFIC FACTORS

A. Information Sources

1. Traffic counts submitted for highway needs studies Are they current? Generally for all season design, current traffic counts should be made and percent commercial should be counted.

2. Note that average daily traffic counts (ADT) are for both directions

3. The ADT used for geometrics is the same as the ADT used for pavement design.

B Traffic Estimate

1. For reconstruction, use a 20 year projection date. For some resurfacing, rehabilitation, or other projects a 10 year projection may be used.

2. If 20-year projection is not available use a compounded growth factor of 3% a year (Current traffic count x 1 03 compounded, at 3% growth per year compounded over twenty years, traffic will approximately double) Use judgment to modify or use the expansion factor for your county as shown in the county road association design manual.

3. Determine traffic in one direction only For design purposes place all traffic in one direction in one lane (1/2 ADT) On multi lane highways use a percent usually 70-80% in the design lane reflecting lane distribution.

4. Determine commercial traffic percentage in design lane Use percent commercial based on updated traffic counts For most county primary roads percent commercial ranges from 8 to 10 unless there is a large commercial traffic generator on the route. In most cases passenger traffic is ignored. Find number of commercial vehicles

5. Find equivalent 18 kip single axle loads (commercial ADT x conversion factor) Conversion factor is 0.544 for medium commercial This is the conversion factor most commonly used Multiply the commercial ADT x 0.544 to determine the Equivalent Single Axle Load (ESAL)

IV REGIONAL FACTOR R Climatic factor considering rainfall, drainage freeze thaw cycles spring breakup

A. Higher factors are more critical for Michigan.

R = 3 0 South 2 tiers of counties
R = 3.5 Districts 5 6, and remainder of districts 7 8, and Metro
R = 4 0 Districts 3 & 4
R = 4.5 Districts 1 & 2

Engineering judgment may be used to modify these factors dependent on job conditions

V PRELIMINARY STRUCTURAL NUMBER $\overline{SN}$

A. Use Design Chart for Flexible Pavement Attachment C (pages 9 and 10)

$p_t = 2.0$ ADT < 5000

$p_t = 2.5$ ADT > 5000

B Enter S = Soil Support Value.

C. Enter traffic information. Equivalent 18 Kip Axle loads (Note that chart is set up for daily or total 18 kip loads) If daily traffic is used on chart, it should be for a 20 year design period. If the design is for other than a 20 year design period the total repetition traffic count must be used.

D Read $\overline{SN}$ at appropriate intersect.

VI. WEIGHTED STRUCTURAL NUMBER SN

Is an indication of required total pavement strength, i.e. subbase, base and surfacing

A. Enter $\overline{SN}$ Preliminary Structure Number

B Enter R Regional Factor

C. Read SN weighted structural number

D Pavement sections (layer thickness x material coefficient summation see VIII page 5) should approximate or exceed the SN number

E. Existing Section Layer coefficients (See VIII, page 5) x thickness can be applied to an existing road. If the weighted structural number of the existing road is less than that which is required from the design procedure then the layer coefficient x thickness of proposed additional aggregate, bituminous layers etc. required to meet the design weighted structural number can be determined.

F Modify with engineering judgment and experience. Consider costs material availability traffic maintenance ease of construction etc.

VII. CONTROLS

A. Subbase minimum thickness 12 compacted. May require a thicker subbase For natural sand soils use an available subbase depth of 12

B Aggregate Base minimum thickness 6" compacted. May require thicker aggregate base. (Note that specifications require that the maximum lift thickness of aggregate base for compaction not exceed 6")

C. Bituminous Base (Not required and is more expensive, but may be used to reduce subbase or aggregate base thickness) minimum thickness 2 if used.

D Minimum total thickness of bituminous pavement shown in Bituminous Pavement Design guidelines (Attachment D pages 11 15) Minimum 2.5 (270 pounds per square yard in two courses)

E. The weighted structural number for the above minimum section is 3 07 (12 subbase 6 aggregate, 2.5" bituminous)

VIII COEFFICIENTS = Per Inch of Material

A. Subbase
See Soil Support Chart (Attachment A, page 7) Ranges from 0 05 to 0 13 usually 0 10

B Aggregate Layers
See Soil Support Chart (Attachment A, page 7) Ranges from 0 12 to 0 15 usually 0 14

Existing Aggregate Base	0 14
Bank Run Aggregate Base	0.12

C. Bituminous Layers (1 of Bituminous on one square yard weighs approximately 110 pounds)

Top	0 42
Leveling	0 42
Binder	0 44
Bit. Base	0.32
Seal Coat	0 14

Recycled Cold Mix Base w/Bituminous Stabilization		0 25
Pulverized Bituminous Base		0 20
Existing Bituminous Surface (Dependent on Condition)	0 14	0 30
Existing Seal Coat		0 14

IX. SAMPLE PROBLEM Refer To Attachment F (pp 20-31)

A. Use Chart p_t = 2.0 Attached (page 9)

B Select and enter soil support value S

C. Determine and enter traffic information

D Read Preliminary Structural Number $\overline{SN}$

E. Select and enter Regional Factor R.

F Read weighted Structural Number SN

G. Using trial thicknesses try alternate pavement sections using coefficients for various layers

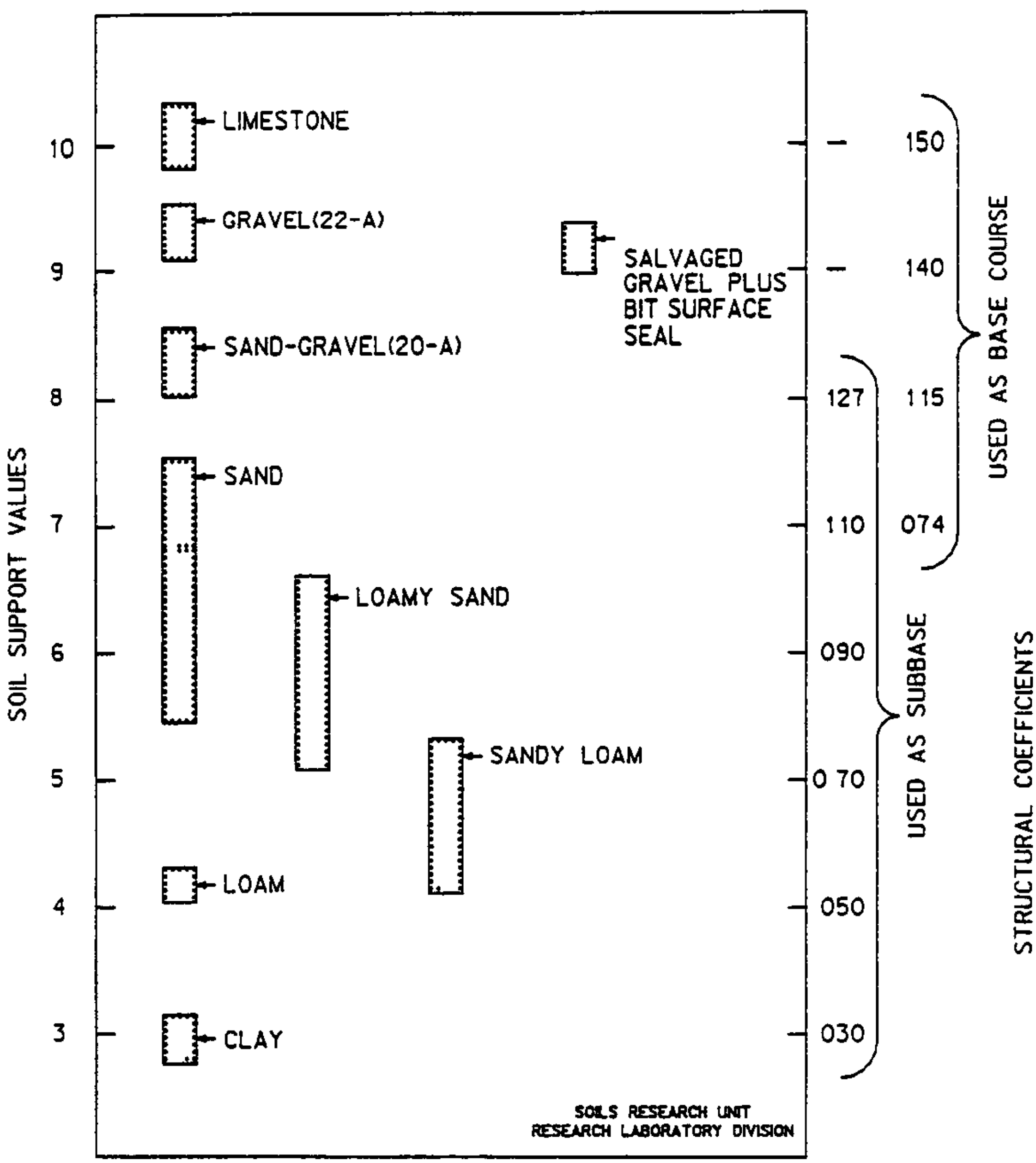
H. Select sections with weighted structural number close to chart value.

I. Determine comparable costs.

J Keep in mind that thicker sections may require more excavation and earthwork, deeper ditches and wider right-of way

K. Make selection based on H J plus engineering judgment.

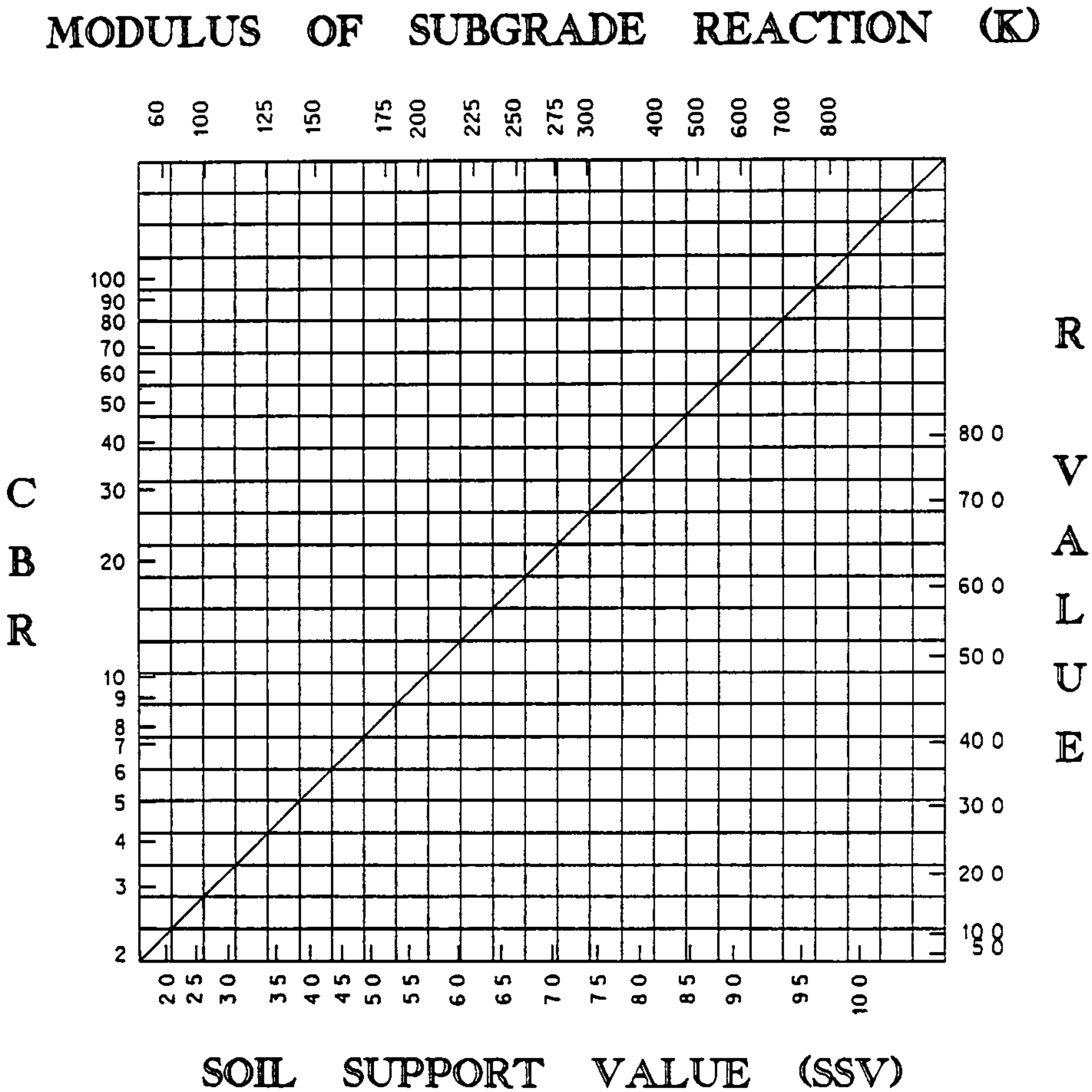
ATTACHMENT A



RANGE OF SOIL SUPPORT VALUES AND COEFFICIENTS FOR VARIOUS MATERIALS.

ATTACHMENT B
(FOR INFORMATION ONLY)

APPROXIMATE CORRELATION BETWEEN
K SSV CBR AND R-VALUE •



•COMPOSITE BASED ON INFORMATION FROM 13 AGENCIES
INVOLVED IN RIGID AND/OR FLEXIBLE PAVEMENT DESIGN

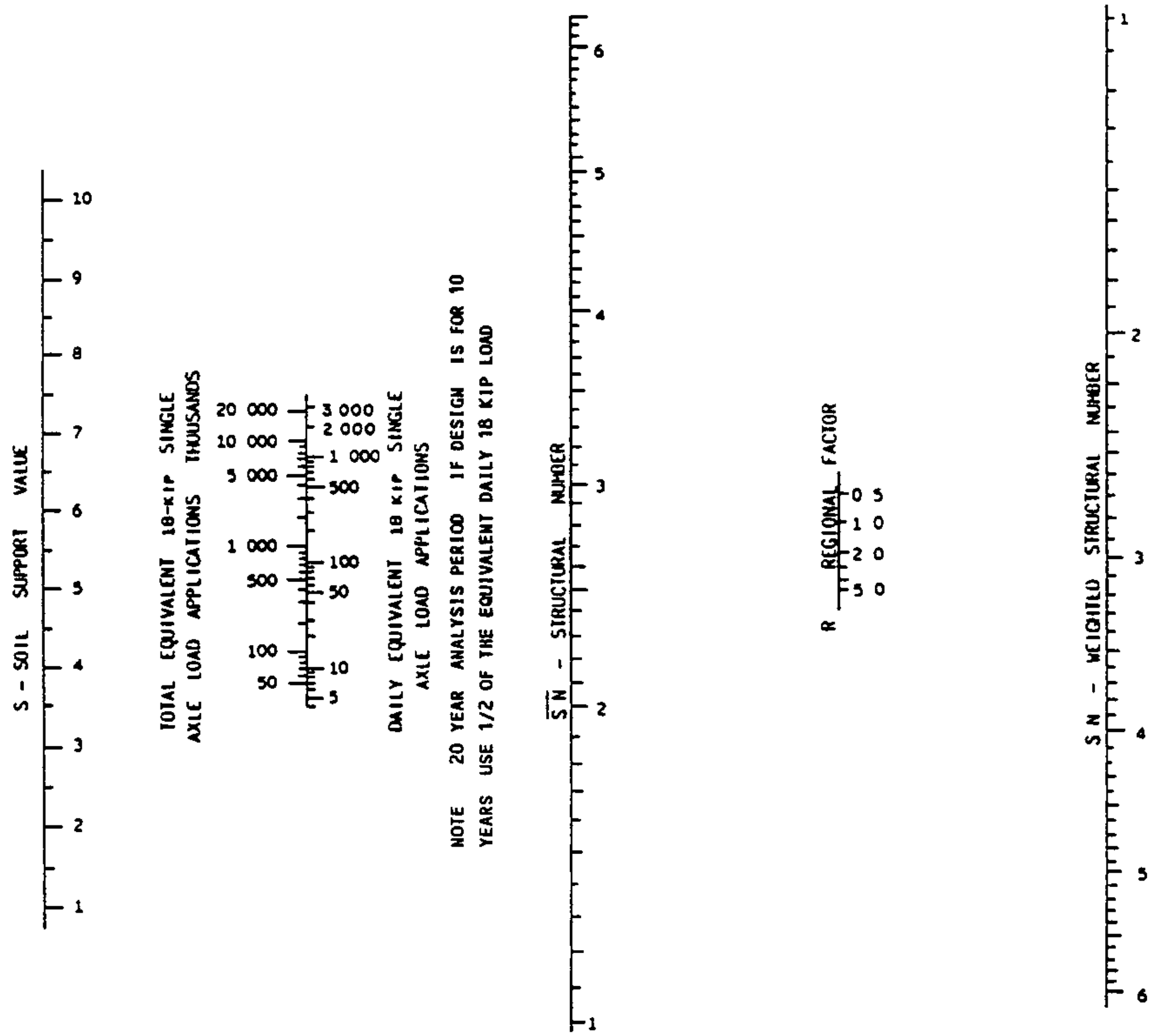


Figure II-2 Design Chart for Flexible Pavements p_t = 2 0

ATTACHMENT C 2

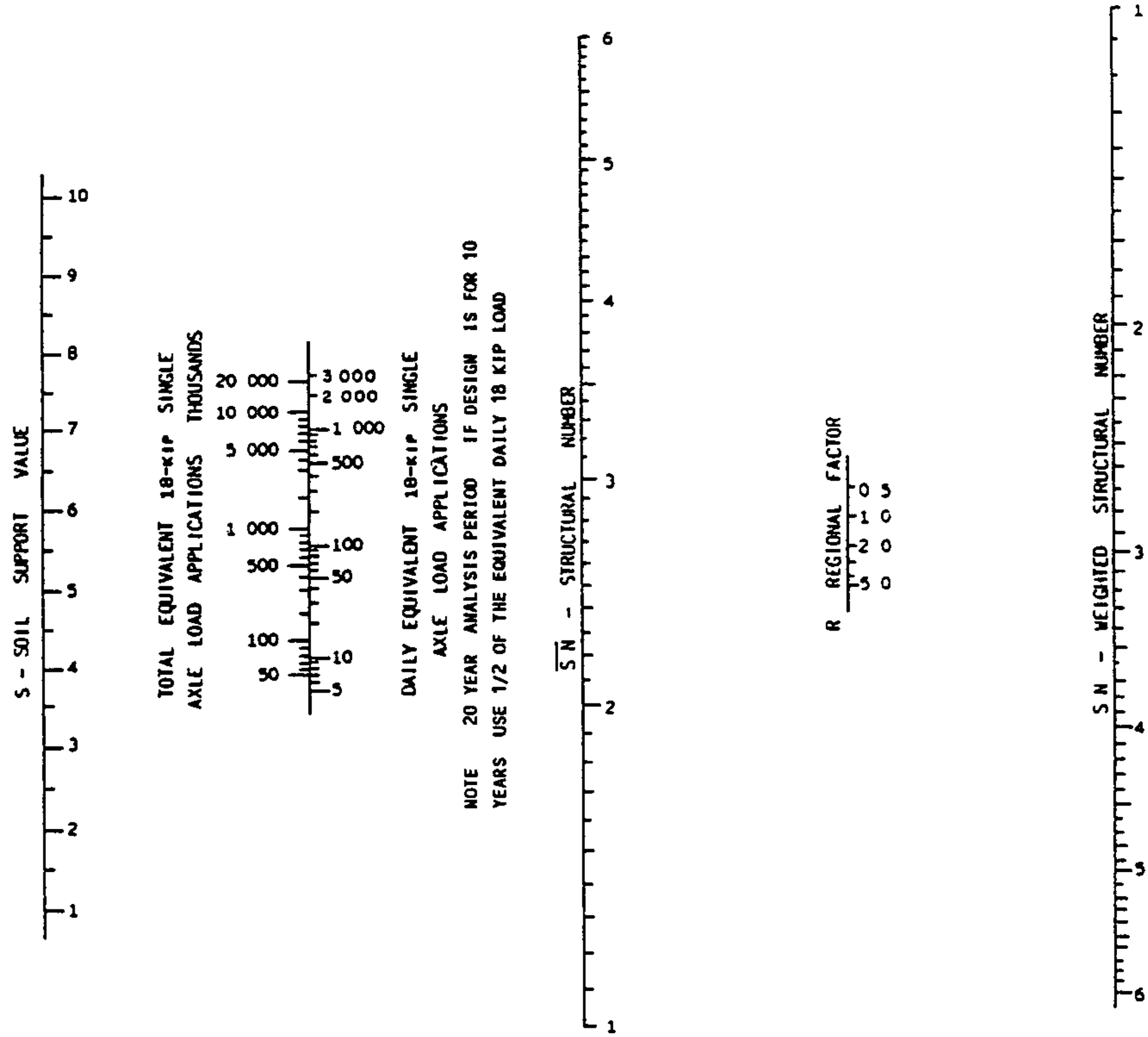


Figure II-1 Design Chart for Flexible Pavements p_t = 2 5

ATTACHMENT D-1

ROADWAY

BITUMINOUS PAVEMENT DESIGN GUIDELINES [1]

Existing Surface	Deterioration [10]	Existing [11] and Proposed Pavement Section		Bituminous [2] Mixture Stability (Lbs.)	Current Commercial ADT in Right Lane [3,5]				
					0–100	100–200	200–500	500–1000	Over 1000
CONCRETE	Moderate			900	A-140 B-130				
				1100		A-140 B-130	A-140 B-130		
				1300				A-140 B-130	
		Top	A	1500					A-140 B-130 or A-120 B-130 C-440
		Leveling	B	1800					Approved by E O C
	Severe	Bit Base	C	900					
		Old Concrete		1100	A-140 B-130	A-140 B-130			
				1300			A-140 B-130		
				1500				A-160 B-160	A-160 B-160 or A-130 B-140 C-440
				1800					Approved by E O C
BITUMINOUS over CONCRETE	Moderate			900	A-160 [7]				
				1100		A-160 [7] or A-130 B-120	A-160 [7] or A-130 B-120		
		Top	A	1300				A-140 B-130	
		Leveling	B	1500					A-140 B-130 or A-120 B-130 C-440
		Bit Base	C	1800					Approved by E O C
	Severe [12]	Old Bituminous		900					
		Old Concrete		1100	A-130 B-120	A-130 B-120			
				1300			A-140 B-130		
				1500				A-160 B-160	A-160 B-160 or A-130 B-140 C-440
				1800					Approved by E O C

Rev 9-22-88

ATTACHMENT D-2

ROADWAY

BITUMINOUS PAVEMENT DESIGN GUIDELINES[1]

Existing Surface	Deterioration[10]	Existing[11] and Proposed Pavement Section	Bituminous[2] Mixture Stability (Lbs)	Current Commercial ADT in Right Lane[3,5] 0-100	100-200	200-500	500-1000	Over 1000
BITUMINOUS over AGGREGATE	Moderate	Top A Leveling B Bit Base C Old Bituminous Aggregate Base	900	A-160[7]				
			1100		A-160[7] or A-130 B-120	A-160[7] or A-130 B-120		
			1300				A-140 B-130	
			1500					A-140 B-130 or A-120 B-130 C-440
			1800					Approval by E O C
	Severe[12]		900					
			1100	A-130 B-120	A-130 B-120			
			1300			A-140 B-130		
			1500				A-160 B-160	A-160 B-160 or A-130 B-140 C-440
			1800					Approval by E O C
BITUMINOUS over AGGREGATE	(New Construction)	Top A Leveling B Bit Base C New Aggregate Base	Final approval by E O C: 900					Delete Agg Base (but retain Agg Base - Bit for working platform)
			1100	A-140 B-130	A-140 B-130			
			1300			A-140 B-130		Use combination of A B & C to satisfy required Structural Number
			1500				A-140 B-130	
			1800					

ATTACHMENT D-3

ROADWAY

ASPHALT PENETRATION (VISCOSITY) RATES [1] [8]

Bituminous Mixture	Current Commercial ADT in Right Lane [3]	
	0 400	Over 400
#500 700 Stability Bit Base	120 150 (AC 5)	85 100 (AC 10)
#900 thru 1800 Stability Bit Surf	120 150 (AC 5)[17]	85 100 (AC 10)
Open Graded Asphalt Friction Course	85 100 (AC 10)	85 100 (AC 10)

GENERAL GUIDELINES FOR RANGE OF APPLICATION RATES

Stability	Aggregate		Application Range lbs /sq yd
	Type	Max Size	
500	20C	1½	220 Minimum
700	20C	1½	220 Minimum
900	20B/20A	¾	130 200
1100	20A/20AA[10]	¾	120 200
[8] 1300	20AAA	¾	120 160
1500	20AAA	¾	120 160
1800	20AAA	¾	120 160
Open Graded Asphalt [9] Friction Course	31A Mod	½	90 120

ATTACHMENT D-4

SHOULDERS

TREATMENT

	Type of Road Construction		Type of Existing Shoulder	Shoulder Treatment
Freeways	New Construction		——	Shoulder type per E O C (See minutes dated 2-3-72) Refer to Standard Plan V-112 Series
	Stabilization in place		Bit mat or seal	Stabilize to 6 max depth Mat thickness same as road resurfacing [15]
	Resurfacing		Bit mat or seal	Surface shoulder same thickness as pavement Substitute Mixture #500 for lower course
	(No work on road)		Bit mat seal or gravel	Stabilize in place 4 depth Bit Mix #1100 mat @ 150 lbs / sq yd min [15]
Rural Free Access Trunklines	New Const	Concrete	——	Bit Mixture #1100 @ 170 lbs / sq yd Bit Mixture #500 @ 300 lbs / sq yd (See Design Note S1 3)
		Bituminous	——	
	Stabilization in place		Bit mat seal or gravel	Stabilize to same depth as roadway 4 min Bit Mix #1100 mat @ 150 lbs / sq yd min [15]
	Resurfacing		Bit mat or seal	Surface shoulder same thickness as road Consider stabilization in place if shoulder is deteriorated [15]
			Gravel	Gravel or 3' bit shoulder ribbon
	(No work on road)		Gravel	Stabilize in place 4 depth plus Bit Mix #1100 mat @ 150 lbs /sq yd min or 3' bituminous shoulder ribbon [15]

3' BITUMINOUS SHOULDER RIBBON

		Current Passenger Vehicle ADT Per Lane [4 5]						
		0 2000		2000 5000			Over 5000	
Lane Width		10'-11' [14]	12'	10'	11' [14]	12'	10'-11'	12'
Lbs per Sq Yd	#500 700	——	——	Widen Pavement	150	——	Widen Pavement	150
	#1100 [19]	250	170 [13]		150	200		150
Penetration [16]		200 250	200 250		200 250	200 250		200 250

ATTACHMENT D-5

FOOTNOTES FOR TABLES

1 THE INFORMATION ON THESE CHARTS IS TO BE USED AS A GUIDE ONLY The Department may vary the design from this criteria if it is determined that there is an excessive amount of commercial traffic excessive stopping, lane concentration steep grades or other warranting conditions

2 The bituminous mixture stability will usually be determined on G I On more important projects it may be selected by T & R

3 To determine volume of commercial vehicles in right lane divide total commercial vehicle count by 2 For 4 lanes or more divide total commercial vehicle count by 2 and multiply by 80%

4 When using " 3' Bituminous Shoulder Ribbon " table on page B1-1c consider five lanes same as four seven same as six etc

5 For new construction use ADT 10 years hence or stage construction

6 For steep grades or heavy commercial traffic change 120 150 penetration to 85 100

7 Provide additional quantity if recommended on G I to correct severe wheel rutting or other distortion

8 Avoid rates of application for leveling and top greater than 200 and less than 250 lbs / sq yd as being too thick for one course and too thin for two courses

9 To be used as an open textured surface course when recommended by G I where speed is 40 mph or more Use in conjunction with a top course unless existing surface is smooth and undistorted bituminous Do not use on existing pavements that are prone to extensive reflective cracking

10 All Bituminous Mixture #1100 in urban areas will be 20AA

11 The term leveling course " is here used as a generic term referring to a first course intended to be covered by a surface or top course It does <u>not</u> refer to Mixture #12LC

12 Consider recycling of all or part of existing surfacing

13 The bituminous shoulder ribbon should be placed on a suitable aggregate base Base requirements and bituminous thickness to be determined on G.I

14 Consider alternate of doing any future widening now in lieu of 3' shoulder ribbon

15 Minimum practical width possible by present stabilization in place equipment is 3' The stabilization should be the same width as the shoulder surfacing

16 If ribbon is paved in conjunction with road resurfacing penetration can be changed to that of road material

17 For rural projects in the northern part of the state consider the use of 200 250 penetration for #900 and #1100 mixes

18 The determination of whether moderate or severe will be made by the Design Division Field Engineer (Lansing) on G I The estimated additional cost for resurfacing severe deterioration (as compared to moderate) is $0 65 per sq yd based on a price of $25/ton of mix

19 Bituminous shoulder ribbon should be same mixture as traveled lanes if paved in conjunction with road resurfacing

ALL SEASON LOADING OUTLINE RIGID PAVEMENT DESIGN

I Serviceability Index p_t

A. As developed in the AASHTO road test, reflects pavement condition at end of design period, usually 20 years

B For most reconstruction, widenings resurfacings secondary trunklines turnbacks federal aid secondary county primary and other lower volume routes with ADT's less than 5000 use p_t = 2.0 Chart.

When the ADT exceeds 5000 use p_t = 2.5 Chart

C. Both serviceability index charts are attached. Attachment E 1 E 2 (pp 18 and 19)

II. TRAFFIC FACTORS ESTIMATED

A. Information Sources

1 Traffic counts submitted for highway needs studies Are they current? Generally for all season design current traffic counts should be made and percent commercial should be counted

2. Note that average daily traffic counts (ADT) are for both directions

3 The ADT used for geometrics is the same as the ADT used for pavement design

B Traffic Estimate

1 For reconstruction, use a 20 year projection date For some resurfacing, rehabilitation or other projects a 10 year projection may be used

2. If 20-year projection is not available use a compounded growth factor of 3% a year (Current traffic count x 1 03 compounded at 3% growth per year compounded over twenty years traffic will approximately double) Use judgment to modify or use the expansion factor for your county as shown in the county road association design manual.

3 Determine traffic in one direction only For design purposes, place all traffic in one direction in one lane (1/2 ADT) On multi lane highways use a percent, usually 70-80% in the design lane reflecting lane distribution

4 Determine commercial traffic percentage in design lane Use percent commercial based on updated traffic counts. For most county primary roads percent commercial ranges from 8 to 10 unless there is a large commercial traffic generator on the route. In most cases passenger traffic is ignored. Find number of commercial vehicles

5 Find equivalent 18 kip single axle loads (commercial ADT x conversion factor) Conversion factor is 0.544 for medium commercial. This is the conversion factor most commonly used. Multiply the commercial ADT x 0 544 to determine the Equivalent Single Axle Load (ESAL)

III. CONCRETE WORKING STRESS f_t

A. Concrete 6 sack mix using Type IA cement, minimum 28 day Modulus of Rupture 650 psi. (From current 1984 MDOT Specifications)

B Working stress f_t equals seventy five percent of Modulus of Rupture. f_t = (650 x 0 75) = 490 psi working stress. May be varied in special cases

IV MODULUS OF SUBGRADE REACTION K

A. K equals 200 for normal 10-12 subbases over clay soil. Based on plate load tests See MDOT Soils Manual page 121

B In the application of the Modulus of Subgrade Reaction the following is assumed

1 Subgrades have been corrected where required to prevent frost heaves

2. Proper grade heights are designed.

3 Unsuitable material such as topsoil peat, etc. has been removed.

4 Suitable compaction has been obtained

V CONTROLS

A. Minimum subbase thickness 10" (Preferred)

B Usual aggregate base thickness 4 Open graded drainage course used on all high volume routes and other selected projects.

C. Minimum slab thickness 7" maximum 11 usually 9 thickness

VI SAMPLE PROBLEM Refer To Attachment F (pp 20-31)

A. Use Design Chart for Rigid Pavements Attachment E (pages 18 & 19)

p_t = 2.0 ADT < 5000

p_t = 2.5 ADT > 5000

B Determine and enter traffic information

C. Enter working stress of concrete f_t.

D Intersect pivot line with straight line determined by points above

E. Enter modulus of subgrade support K.

F Determine straight line from K to pivot point.

G Read D slab thickness inches

H. Round up thickness to nearest 1/4

ATTACHMENT E 1

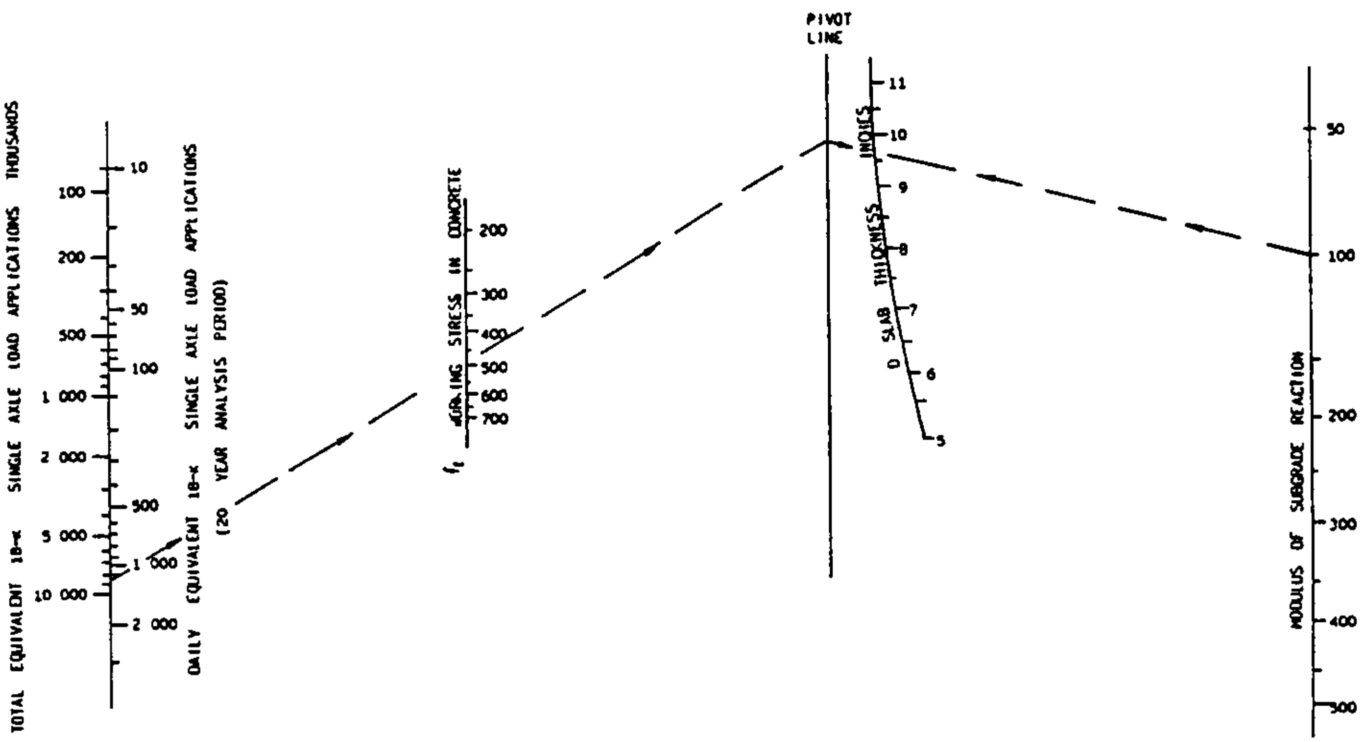
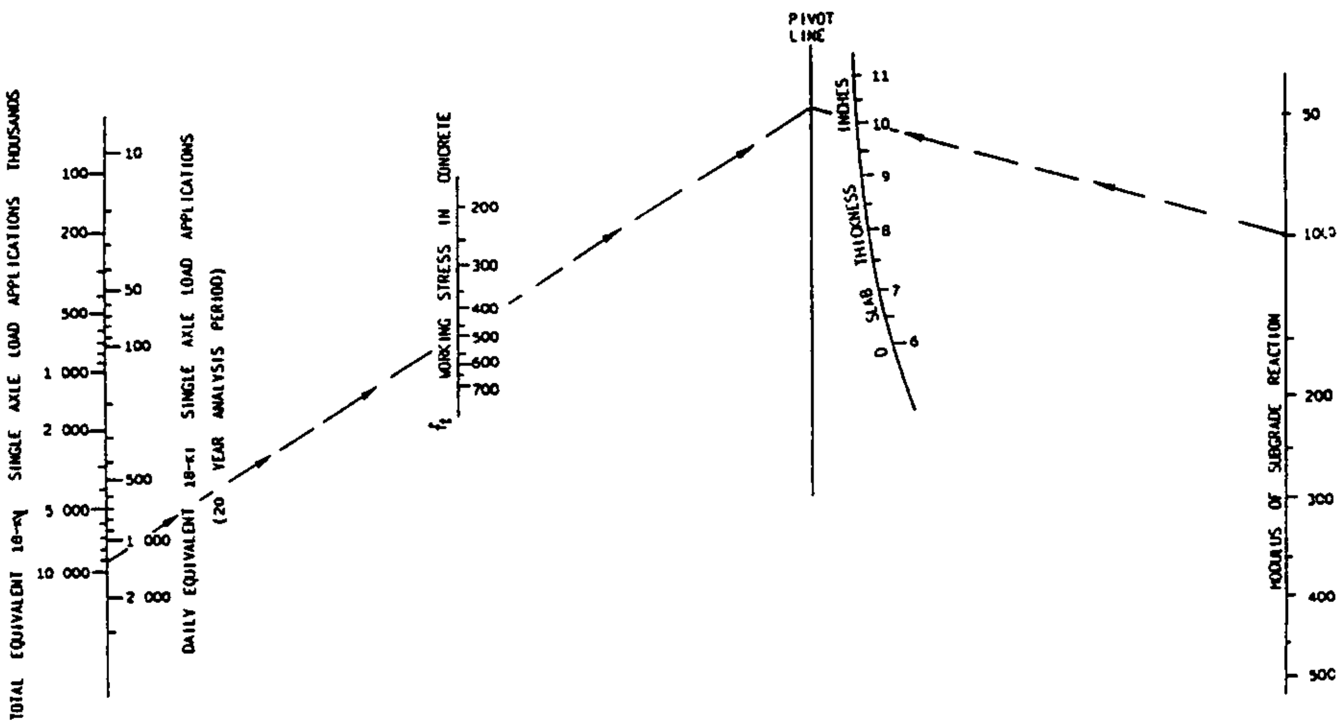


Figure III 2 Desig Chart fo Rigid Paveme ts p_t 2 0



Figu e III-1 Design Chart for Rigid Pavements p_t 2 5

ATTACHMENT F

Example Problem and Computations

for

Flexible and Rigid Pavement Design

ATTACHMENT F 1

Soil Borings

T.H. #6 0.25 Mile North of Primary Road & 5.3 Left of Right Edge of Metal

0.00	0.35	Bituminous
0.35	0.75	Gravel
0.75	1.50	Stiff Sandy Gray Brown Clay w/ Occasional Pebbles
1.50	2.60	Fine Brown Sandy Loam w/ Traces of Topsoil
2.60	3.00	Fine Light Brown Sandy Loam
3.00	3.50 +	Mottled Plastic Silty Clay

T.H. #7 0.75 Mile North of Primary Road & 2 Left of Right Edge of Metal

0.00	0.45	Bituminous
0.45	0.80	Gravel
0.80	1.60	Mottled Plastic Sandy Clay
1.60	1.90	Dark Sandy Loam Topsoil
1.90	3.00'	Plastic Sandy Clay Loam w/ Pebbles
3.00'+		Mottled Plastic Sandy Clay w/ Pebbles

T.H. #8 1.25 Miles North of Primary Road & 8' Left of Right Edge of Metal

0.00	0.35	Bituminous
0.35	1.20	Gravel
1.20	1.80	Mixture of Pebbly Sandy Loam & Firm Sandy Clay
1.80	2.50	Firm Sandy Clay w/ Pebbles
2.50	3.00'+	Plastic Sandy Clay

T.H. #9 1.7 Miles North of Primary Road & 2 Left of Right Edge of Metal

0.00	0.20'	Bituminous
0.20	0.60	Oil Aggregate
0.60	0.90	Gravel
0.90	1.20	Dark Pebbly Sandy Loam
1.20	1.90	Dark Loam Topsoil
1.90	3.30	Plastic Yellow Brown Sandy Clay Loam w/Pebbles
3.30	3.50'+	Plastic Yellow Brown Sandy Clay

ATTACHMENT F 2

TH #10 2.2 Miles North of Primary Road & 7' Left of Right Edge of Metal

0.00	0.25	Concrete
0.25	0.55	Oil Aggregate
0.55	1.20	Gravel
1.20	1.60	Stiff Gray Sandy Clay
1.60	2.00	Stiff Gray Brown Clay
2.00	3.00 +	Firm Mottled Gray Brown Clay

TH #11 2.7 Miles North of Primary Road & 2 Left of Right Edge of Metal

0.00	0.30	Bituminous
0.30	0.50	Oil Aggregate
0.50	1.00	Gravel
1.00	3.00	Mixture of Dark Sandy Loam and Plastic Gray Brown Sandy Clay
3.00 +		Plastic Mottled Gray Brown Clay

ATTACHMENT F 3

Regional Factor = 3.5 (Mid Michigan Area, District 6)

Existing Bituminous Depth = 4

Existing Gravel Base Depth = 6

Soil Support Value = 3 (Loams and Clays)

Present Traffic Volumes = 1500 ADT at 4% Commercial

Step 1 Convert Traffic to Equivalent 18 Kip Single Axle Load (ESAL)

Existing ESAL =

<u>Step 1</u>

1 Determine traffic in one direction only and for design lane. Proposed two lane pavement. Divide ADT by 2

$$\frac{1500}{2} = 750$$

2. Determine commercial traffic percentage in design lane

$$750 \times 0.04 = 30 \text{ Commercial ADT in Design Lane}$$

3 Convert commercial traffic to equivalent 18 Kip Single Axle Loads (ESAL)

$$30 \times 0.544 = 16.3 \text{ Existing ESAL/Day}$$

<u>Step 2</u>

Evaluate Four (4) Alternatives

1 New Bituminous Pavement
2. New Concrete Pavement
3 Overlay Existing Pavement
4 Mill 2 Bituminous (to be hot recycled) Pulverize Remaining 2 Bituminous Overlay with Recycled Hot Mix

ATTACHMENT F-4

Alternative 1 New Bituminous Pavement

Design Life	=	20 Years
Terminal Serviceability p	=	2.0
Anticipated Rate of Traffic Increase	=	3%
Year 20 ESAL = $(16.3)\ (1+0\ 03)^{20}$	=	29 ESAL/Day

Design Life

Rate of Increase/100

Present ESAL(from page 23)

From Nomograph (Attachment C-1 page 9) Required SN = 3.5
(Refer to Attachment F-4a, page 25)

Try Minimum Section (Coefficients from page 5)

270 psy Leveling & Top	$\frac{270\ (0\ 42)}{110}$	=	1 03
6 Aggregate Base	(6") (0 14)	=	0 84
12 Subbase	(12)(0 10)	=	1 20
	SN	=	3 07 (Does Not Meet)

Increase Leveling & Top and Subbase

160 psy Top Course 170 psy Leveling	$\frac{330\ (0\ 42)}{110}$	=	1 26
6" Aggregate Base	(6")(0 14)	=	0 84
15 Subbase	(15")(0 10)	=	1 50
	SN	=	3 60 (O K Meets)

ATTACHMENT F-4a

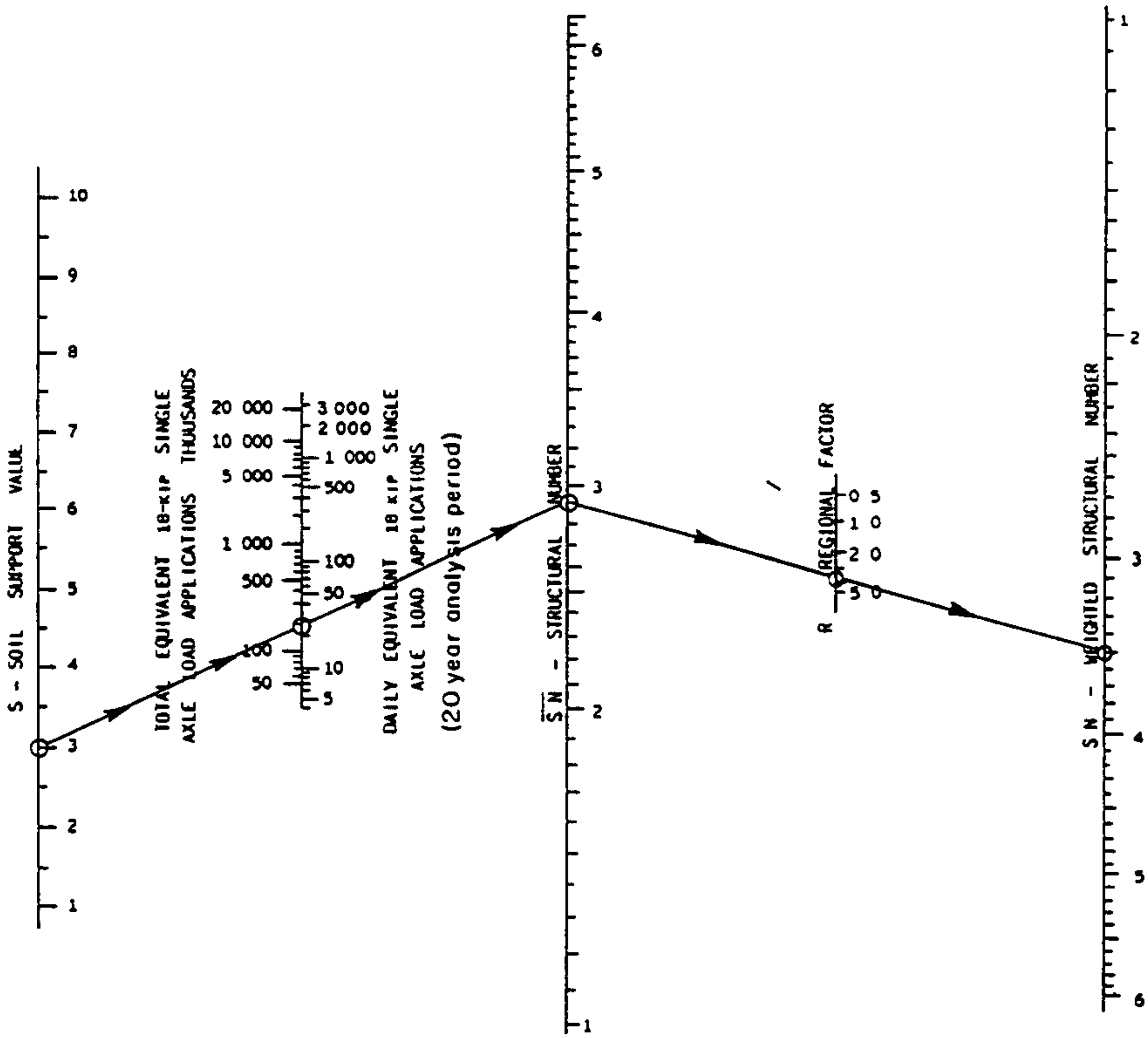


Figure II-2 Design Chart for Flexible Pavements $p_t = 2\ 0$

ATTACHMENT F 5

Alternative 2 New Concrete Pavement (Refer to Attachment E 1 page 18)

Design Life	=	20 years
Terminal Serviceability p_t	=	2.0
Concrete Working Stress f_t (Refer to page 17)	=	490
Year 20 ESAL	=	29 ESAL/Day(See Alternative 1 Attachment F-4 page 24)
Modulus of Subgrade Reaction K (Refer to page 17)	=	200 (on 10" Subbase)

From Nomograph (Attachment F 5a, page 27) Depth Required = 5
(Refer to Attachment F 5a, page 27)

Use minimum of 7" on 10" Subbase
+ 4 aggregate base-concrete or open
graded aggregate.

ATTACHMENT F 5a

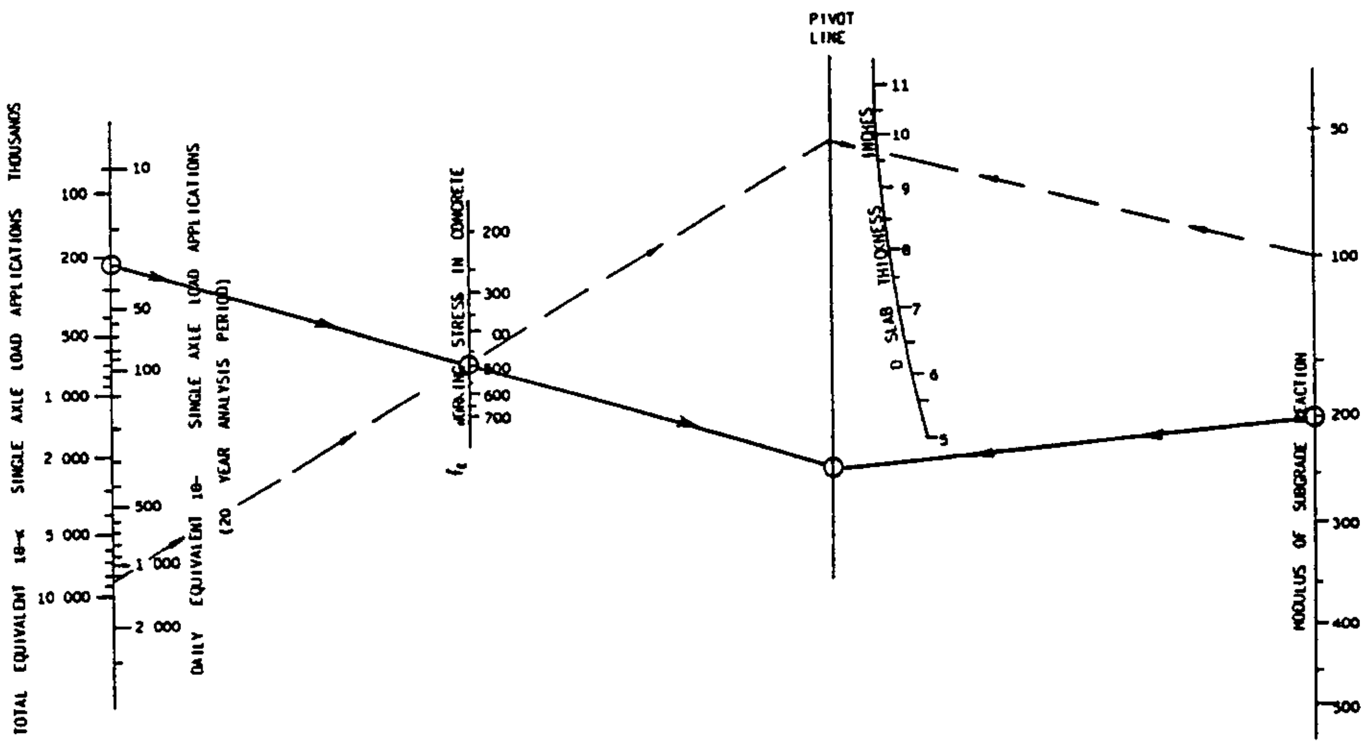


Figure III-2 Design Chart for Rigid Pavements $p_t = 2\ 0$

ATTACHMENT F-6

Alternative 3 Overlay

Design Life	=	10 Years
Serviceability Index P_t	=	2.0
Year 10 ESAL = (16.3) $(1\ 03)^{10}$ (16.3 from page 23)	=	22 ESAL/Day
10 Year Accumulated ESAL	=	22 (365)(10) = 80,000

Use Accumulated ESAL of 80 000 on Nomograph (Attachment F-6a, page 29) (Daily ESAL applies only to 20 year design life)

From Nomograph Required SN	=	3 1 (Refer to Attachment F-6a, page 29)
Existing Bituminous In Poor Condition	=	Try A Structural Coefficient of 0 14 to 0 20 (From page 5)

Existing Section (Refer to Attachment F 3 page 23)

Bituminous (4") (0 14) to 4 (0.20)	=	0.56 to 0 80 (Coefficients from page 5)
Existing Aggregate Base (6") (0 14)	=	0 84 (Coefficient from page 5)
Existing SN	=	1 40 to 1 64

Additional Structural Number Required Ranges From (3 1 1 64 or 3 1 1 40) = From 1 46 To 1 70

Additional Bituminous Leveling & Top Thickness Required

$$= \frac{1\ 46}{0\ 42} \quad \text{or} \quad \frac{1\ 70}{0\ 42} \qquad \text{Ranges from } 3\ 5 \text{ to } 4\ 0$$

Based on County Engineer's experience with overlays on roadways in other areas in this condition with similar soils and traffic, a 10 year life for a 3 1/2 overlay is reasonable Use 180 psy Top Course and 200 psy Leveling Course.

$$\text{Additional SN} = \frac{380\ (0\ 42)}{110} = 1\ 45$$

Total SN ranges from (1 40 + 1 45 = 2.85) to (1 64 + 1 45 = 3 09)
Meets required SN of 3 1 O.K.

Note that existing cracks will show through as reflective cracking.

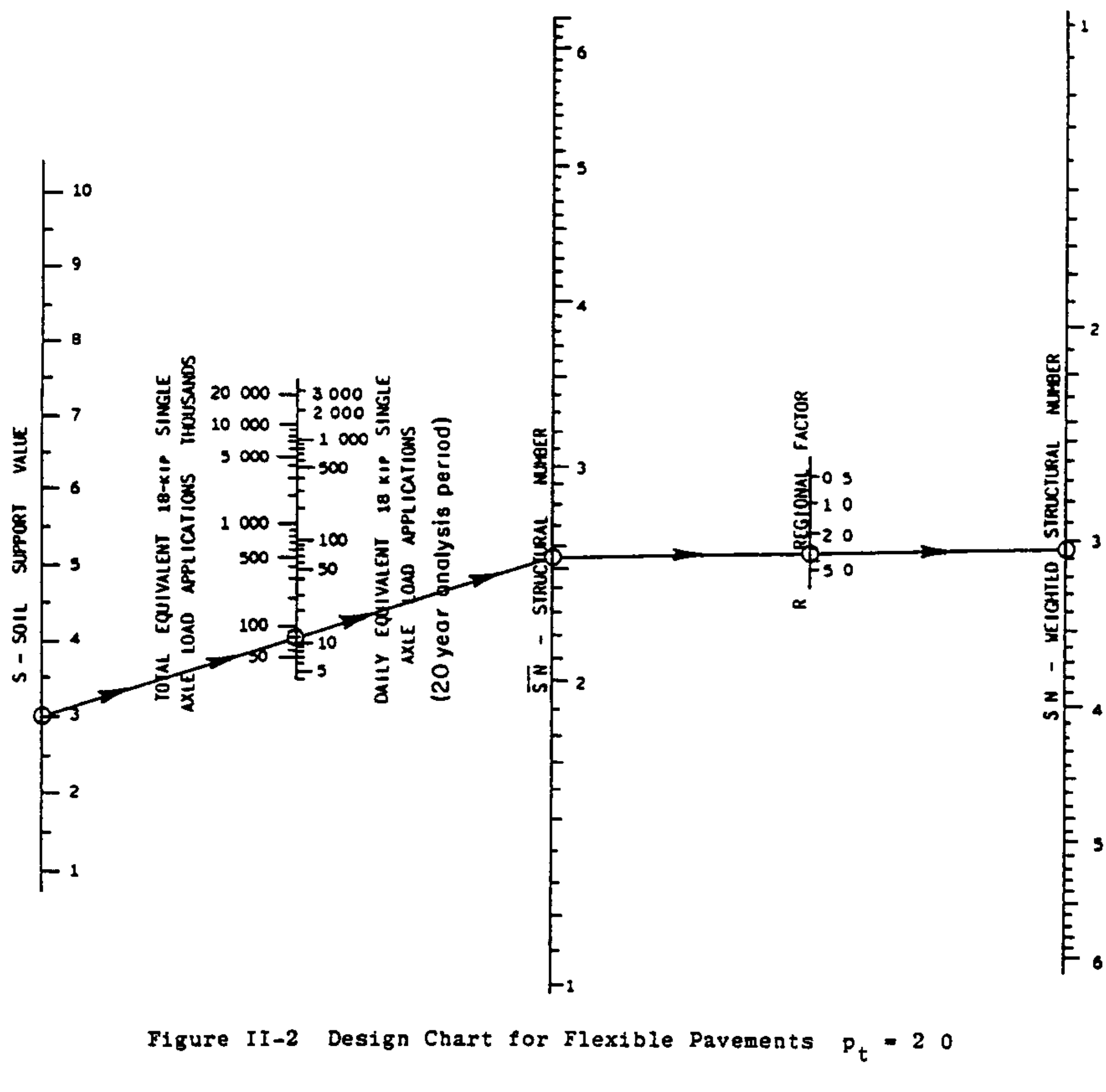


Figure II-2 Design Chart for Flexible Pavements $p_t = 2\ 0$

ATTACHMENT F 7

Alternative 4 Mill, Pulverize, and Overlay

Design Life	=	20 Years
Required SN	=	3.5(See Alternative 1 Attachment F-4 page 24)

Try 270 psy Overlay

270 psy Leveling & Top	$\frac{270\ (0\ 42)}{110}$	=	1 03
Pulverized Bituminous	(2") (0.20)	=	0 40 (Coefficients from page 5)
Existing Aggregate Base	(6") (0 14)	=	0 84 (Coefficients from page 5)
	SN	=	2.27 Not Adequate

Additional Bituminous Base Try 330 psy(3")(0.32) = 0 96 (Coefficients from page 5)
Total SN = 0 96 + 2.27 SN = 3 23 (Does Not Meet)

Try adding aggregate base try 2

270 psy Leveling & Top	$\frac{270\ (0\ 42)}{110}$	=	1 03
330 psy Bituminous Base	(3) (0.32)	=	0 96
Pulverized Bituminous	(2") (0.20)	=	0.40
8" Aggregate Base (Ex. 6 + 2 Additional)	(8) (0 14)	=	1 12
	SN	=	3.51 (O K. Meets SN)

Other combinations with different depths of milling (0-4") and different depths of pulverizing (0-4) may be considered.

ATTACHMENT F-8

1 Make a cost estimate of the four (4) alternatives.

2. Consider maintaining or detouring traffic; ease and time of construction, availability of materials and future maintenance costs of each alternative.

3 Consider that thicker sections may require more excavation and earthwork, deeper ditches and wider right-of way

4 Make final decision of pavement section based on above. Realize that alternative three (3) is for 10 years while the others are for 20 years.